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(54) FLUID APPARATUS

(71) We, ROLLS-ROYCE LIMITED, formerly Rolls-Royce (1971) Limited, a British Company, of 65 Buckingham Gate, London SW1E 6AT, formerly of Norfolk House, St. Jame's Square, London SW1Y 4JR, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to fluid apparatus.

It is sometimes desirable or necessary with fluid apparatus such as a hydraulic or pneumatic powered mechanism, to increase the power of the mechanism and it is common to do this with the use of a servo system. Such a system usually constitutes means for detecting a change in the mechanism which switches into operation a pneumatic or hydraulic power supply, for example, which acts to boost the power of the mechanism by assisting or resisting the change.

It is an object of present invention to provide fluid apparatus with a servo system with an improved degree of control over the operation of the servo system.

According to the present invention fluid apparatus comprises a first chamber adapted to be supplied with a fluid at a predetermined pressure, a second chamber adapted to receive a supply of pressurised fluid, valve means for controlling the pressure of the pressurised fluid supplied to the second chamber and duct means connecting the first chamber to the valve means, whereby the pressure existing in the first chamber is operable to adjust the valve means until the pressure of the fluid supplied to the second chamber is substantially the same as that existing in the first chamber, the valve means comprising a spool valve having a movable spool which is adapted to prevent or permit the supply of pressurised fluid to the second chamber, the spool being positioned by a balance between the pressure existing in the first chamber acting on one end of the spool and the pressure existing in the second chamber acting on the opposite end of the spool assisted by a spring loading whereby when the pressure in the second chamber is substantially the same as the pressure in the first chamber, no resultant fluid pressure exists on the spool, and the spool is positioned by the spring loading to prevent the supply of pressurised fluid to the second chamber.

Preferably the first and second chamber comprise first and second cylinders in each of which is a movably mounted piston. These pistons may be single or double acting.

When the first and second pistons are double acting, two spool valves may be provided, the pressure existing on one side of the first piston being communicated to one spool valve, and the pressure existing on the other side of the first piston being communicated to the other spool valve.

The fluid is preferably air.

It will thus be seen that the pressure in the second cylinder is at all times substantially the same as that existing in the first cylinder, and the apparatus is thus a pressure follower. The apparatus therefore may be used to power one or more additional rams to increase the power available from a single first ram.

An embodiment of the invention will now be described by way of example only, with reference to the accompanying drawing which is a schematic arrangement of an assembly of pneumatic rams in accordance with the invention.

The arrangement shown is adapted to operate the actuating ring 10 of a plurality of variable guide vanes 12 of a gas turbine engine (not shown). It consists of a master ram 14 comprising a cylinder 16 containing a double acting piston 18. Both sides of the piston 18 are supplied with pressurised air *via*

ducts 20 and 22 from a fluidic control unit 24. The piston 18 is connected by rod 26 to one arm of a bell-crank lever 28 which is pivoted on a stub shaft 30, the other arm of the bell crank lever being connected to the actuating ring 10 by a link 32.

The bell-crank lever 30 is also acted on by a rod 34 which is moved by a slave ram 36, this ram acting in the opposite direction to the master ram 14 to impart a couple on to the bell-crank lever 28. The slave ram is powered directly from the master ram 14, a duct 38 connecting the right-hand side of the cylinder 16 to the left-hand side of the cylinder 40 of the slave ram 36, and a duct 42 connecting the left-hand side of the cylinder 16 to the right-hand side of the cylinder 40 so that the piston 44 of the slave ram 36 moves in the opposite direction to the piston 18.

To increase the power of this arrangement such as by adding an additional ram 46, would involve increasing the size of the fluidic control unit 24 to provide a greater quantity of air at the required pressure. In this particular application the fluidic control unit is very complex and would thus need a major redesign to provide this increased mass flow of air. The additional ram 46 therefore is adapted to be operated by a separate supply of air.

Air at a pressure P4 is therefore tapped off a main air supply duct 50 to the fluidic control unit 24 and taken along a duct 48, bypassing the control unit 24, to a pair of spool valves 52 and 54. The duct 48 also includes an air filter 49.

The additional ram 46 is virtually the same as the master ram 14, comprising a cylinder 56 and a double acting piston 58. The piston is connected to a rod 60 which in turn is connected to the actuating ring 10 via a further bell-crank lever 62 and a link 64.

The two spool valves 52 and 54 are identical, each comprising a chamber 66 and a movable spool 68. Each end of the spool is adapted to be acted on by a piston 70 (on the left) and 72 (on the right) and the spool 68 is urged by a spring 74 towards a central position as shown in the figure. A duct 76 connects the left-hand end of the chamber 66 to the duct 42, thus communicating the pressure acting on the left-hand side of the piston 18 to the piston 70. The duct 48 extends into the chamber 66 and an outlet duct 80 extends from the chamber 66 to the left-hand side of the cylinder 56. The piston 72 is adapted to be acted on by the pressure existing in the outlet duct 80 by means of a connecting duct 82 connecting the outlet duct 80 with the right-hand end of the chamber 66.

In operation, the fluidic control unit 24 supplies air at a pressure of, for example, 100 p.s.i. along the duct 20 to the left-hand side of the cylinder 16. This air is also conveyed along the duct 76 to the left-hand end of the chamber 66. Once these parts reach the pressure of 100 p.s.i. there is no constant flow of air through the system. Since the pressure in the duct 22 is lower than 100 p.s.i., (it may for example be at atmospheric pressure) the piston 18 moves to the right along with the rod 26. The bell-crank lever rotates in an anti-clockwise direction and moves the actuating ring 10 in the direction of the arrow 100. Similarly, in the slave ram 36, the piston 44 moves to the left.

The pressure of 100 p.s.i. also acts on the piston 70, and the spool 68 thus moves against its spring 74 to the right so that the land 84 uncovers the outlet duct 80. The air at a pressure of P4 in the duct 48 thus passes through the outlet duct 80 into the left-hand end of the cylinder 56 and into the right-hand end of the chamber 66 to act on the piston 72. As the pressure acting on the piston 72 approaches 100 p.s.i. it balances the pressure acting on the piston 70, and the spring 74 thus urges the spool back to its central position until the outlet duct 80 is covered by the land 84 and the supply of air at the pressure P4 to the cylinder 56 is stopped. The piston 58 moves to the right under the action of approximately 100 p.s.i. as in the master ram 14. The movement and power output from the additional ram 46 is thus substantially the same as the master ram 14.

Since the master ram 14 and the slave ram 34 are double acting, the additional ram 46 is also double acting, and an additional duct 78 connects the right-hand end of the cylinder 16 to the left-hand end of the spool valve 52. When a pressure of 100 p.s.i. is applied along the duct 22 therefore, the spool valve 52 operates in exactly the same manner as the spool valve 54 to move the piston 58 to the left.

When the pressure in the duct 20 drops below 100 p.s.i., the pressure acting on the piston 70 falls, thus permitting the spool to move to the left under the action of the pressure of 100 p.s.i. acting on the piston 72. The land 84 uncovers the outlet duct 80 and connects it with an exhaust hole 86 found in the chamber 66. The pressure in the left-hand side of the cylinder 56 thus falls, as does the pressure acting on the piston 72 until the pressures acting on the pistons 70 and 72 are substantially equal. The spool then moves back to its central position under the action of the spring 74 to cover the outlet duct 80.

The apparatus is particularly suitable for increasing the power of hydraulic or pneumatic apparatus without the necessity of increasing the output capacity of the control system.

WHAT WE CLAIM IS:—

1. Fluid apparatus comprising a first

chamber adapted to be supplied with a fluid at a predetermined pressure, a second chamber adapted to receive a supply of pressurised fluid, valve means for controlling the pressure of the pressurised fluid supplied to the second chamber and duct means connecting the first chamber to the valve means, whereby the pressure existing in the first chamber is operable to adjust the valve means until the pressure of the fluid supplied to the second chamber is substantially the same as that existing in the first chamber, the valve means comprising a spool valve having a movable spool which is adapted to prevent or permit the supply of pressurised fluid to the second chamber, the spool being positioned by a balance between the pressure existing in the first chamber and acting on one end of the spool and the pressure existing in the second chamber acting on the opposite end of the spool assisted by a spring loading whereby when the pressure in the second chamber is substantially the same as the pressure in the first chamber, no resultant fluid pressure exists on the spool, and the spool is positioned by the spring loading to prevent the supply of pressurised fluid to the second chamber.

2. Fluid apparatus as claimed in claim 1 in which the first and second chambers comprise first and second cylinders in each of which is a movably mounted piston.

3. Fluid apparatus as claimed in claim 2 in which the pistons are single acting.

4. Fluid apparatus as claimed in claim 2 in which the pistons are double acting.

5. Fluid apparatus as claimed in any one of claims 1, 2 or 4 in which the first and second pistons are double acting and two spool valves are provided, the pressure existing on one side of the first piston being communicated to one spool valve, and the pressure existing on the other side of the first piston being communicated to the other spool valve.

6. Fluid apparatus as claimed in any preceeding claim in which the fluid is air.

7. Fluid apparatus constructed and adapted to operate substantially as hereinbefore described with reference to the accompanying drawing.

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Agent for the Applicants.

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1594232 COMPLETE SPECIFICATION

1 SHEET *This drawing is a reproduction of the Original on a reduced scale*